short and small, not one third of its length; the process at the outer base of the third lobe about as large as those at the inner bases of the median lobes; the usual row of glands just beyond the second long process, but they are small, much as in *C. calurus*; anal orifice a long way from the hind end, but still caudad of the level of the posterior circumgenital glands.

Chrysomphalus albopictus (Ckll.).

Mexico: Cuautla, on twigs of rose, May 31, 1897 (*Koebele*, 1769); Cuautla, on *Myrtus* (*Koebele*).

Chrysomphalus agavis (Towns. & Ckll.).

Mexico: on "Tabucha," May 1896 (*Townsend*). Div. Ent. 7217.

Chrysomphalus dictyospermi (Morgan).

Mexico: Oaxaca, on leaves of *Pinus*, Aug. 20, 1897 (*Koebele*, 1697, pars).

Section Melanaspis, Ckll.

Chrysomphalus nigropunctatus (Ckll.).

Mexico: Amecameca, June 6, 1897, "on wild tree resembling tobacco" (*Koebele*, 1740); Mexico city, on bark of maple, May 22, 1897 (*Koebele*, 1741); on *Baccharis glutinosa* at Mixcoac, June 22, 1897 (*Koebele*, 1743).

Chrysomphalus lilacinus (Ckll.).

Mexico: Nogales, on *Quercus undulata*, April 10, 1897 (*Koebele*, 1629).

XXVI.—*Notes on the Tentacles of* Nautilus pompilius. By Lawrence E. Griffin *.

The following notes on the structure and homologies of the tentacles of Nautilus describe points which have been of great interest to me and which seem important enough to justify publication preliminary to a complete account of the anatomy of the Nautilus.

* From the 'Johns Hopkins University Circulars,' November 1898, pp. 11–12.

All the tentacles of the Nautilus are built after a single plan, and preserve the essential features of this even when highly modified. Ordinarily the tentacle is considered to be formed by two parts—a fleshy sheath surrounding an extensile cirrus. The cirrus is the essential structure and will be spoken of as *the tentacle*, while the sheath seems to be merely a fold of the skin which has been produced around the cirrus for protective or supportive purposes. Surrounding the head of the Nautilus are thirty-eight tentacles, to which Owen gave the name of *digital tentacles*. The sheaths of these are fused to each other, so that a complete *Cephalic Sheath* (Owen), open ventrally only, is formed. These tentacles have been described as having no regular arrangement; but an examination of fifty-one specimens proved that they are arranged upon each side in a constant order. Only six specimens showed a variation from the normal arrangement, and this variation existed in each case upon one side only. Whether the same tentacle always occupies the same position or not cannot be decided till after further dissection of the nerves going to the tentacles.

The digital tentacles present the structural plan uniformly and simply. The surface of the tentacle is marked by a close series of annular grooves, which are deepest upon the inner side of the tentacle. The tentacles are frequently flattened upon the inner side. A large nerve-trunk occupies the centre of the tentacle; around this are the radial bundles of longitudinal muscles. Closer examination of the nerve-cord reveals that it is enlarged by collections of ganglion-cells at regular intervals, each enlargement corresponding in position to a segment of the tentacle included between two of the annular grooves. From the ganglionic enlargements nerves pass to the different portions of the segment, but especially to the inner side. The segmental structure of the nerve-cord persists in cases where all traces of the external annulations have disappeared.

Dr. Willey, in a recent article, described the great adhesive power of the digital tentacles. This power seemed strange until after a closer study of the segments of the tentacles. The groove between the segments is much deeper upon the inner face of the tentacles than elsewhere. The inner face of the segment is flattened. On this side, between the epithelium and the longitudinal muscles, are radial transverse muscles—the only transverse muscles in the tentacles which we can surely identify as such.

Their operation would be somewhat as follows:—when the flat surfaces of the segments of the tentacles are applied to any body a contraction of the radial muscles within each segment would pull the central portion away from the opposed surface and cause a vacuum to be formed between the segment and the surface. The adhesive power of any one segment must be slight; but there are from sixty to one hundred segments in each tentacle, half of which would probably be in a position to hold; and there are thirty-eight tentacles in the group. Thus the combined adhesive power of all the segments is very great.

It seems to me probable that we see here the beginnings of the suckers of the Dibranchiates. As these Cephalopods became more active and predatory the simple sucker would naturally have been modified to form an organ better adapted to quick and sure seizing of the prey. Yet the principle of action is the same in the Nautilus and the Dibranchiates. It seems probable that the projecting portion of each segment of the tentacle formed a single sucker. Growth would cause these to take alternating positions. Possibly from each segment several suckers were formed by subdivision of the adhesive surface and the development of each portion into a sucker. These may have remained arranged in transverse rows, as in *Sepia* and other forms.

This theory of the formation of the suckers of the Dibranchiates necessitates our regarding the arms of the Dibranchiates as each corresponding to a single tentacle of the Nautilus, and not to groups of tentacles. The structure, arrangement, and relations of the arms support the first view far more than the second. Comparison with the processes of change in other orders weakens the latter theory, while strengthening the theory that a few tentacles gradually increased in size while the remainder were crowded aside and reduced.

The *ocular tentacles* present several differences of structure from the digital tentacles. Their sensitiveness is much greater. The greater depth of the annular grooves on the inner side is immediately noticed. Willey has found that the sides of the groove are ciliated. In some instances I find the cilia extending over the surface between the grooves.

Of internal structure two points are especially remarkable. One is struck by the ease with which the tips of the ocular tentacles break off. This seems to be the result of a peculiar arrangement. In the plane of the annular groove the adjoining segments are separated by what in sections appears as a plain line along which the tissues are evidently weaker than elsewhere. In apparently normal cases there is no separation of the tissues, but the weak line appears sharply and distinctly. The line does not extend through the epidermis or the nerve-cord. The lines are only found in the upper portions of the tentacles. It is difficult to understand of what use this arrangement can be. The tips of the tentacles break off with exceeding ease; but can this be in any way advantageous to the Nautilus?

The other point is regarding the structure of the nerve-trunk. There is here what I have termed an *accessory nerve-trunk*. The usual nerve-trunk is present, having its layer of ganglionic cells around its periphery and its ganglionic enlargements in each segment of the tentacle. On the inner side of this, through nearly the entire length of the tentacle, runs a large nerve-trunk, composed of several bundles of nerve-fibres. The main nerve-trunk and the accessory are closely united, but are easily distinguished by the layer of ganglion-cells which surrounds the main trunk. There are very few, if any, ganglion-cells in the accessory trunk. At the ends of the tentacle the accessory trunk gradually disappears, at the upper end by giving off nerves chiefly to the inner side of the tentacle, at the base of the tentacle by gradual union with the main nerve-trunk.

This accessory trunk has apparently been developed in connexion with the remarkable sensitiveness of the ocular tentacles.

The nerves of the two ocular tentacles of each side are branches of a nerve which comes off from the pedal ganglion near the outer end, which also sends branches to the hood.

The hood consists of the fused and enormously enlarged sheaths of the dorsal digital tentacle of each side. The origin of the nerves of the ocular tentacles in the pedal ganglia, and the fact that they form portions of nerves going to the sheaths of digital tentacles, proves, as Dr. Willey has suggested, that the ocular tentacles cannot be considered as other than somewhat modified (and perhaps displaced) digital tentacles, and that they can in no wise be considered as the homologues of the optic tentacles and rhinophores of Gastropods.

There is in the female Nautilus, ventral to the buccal mass, a fleshy lobe, which, dividing into two near its tip, bears upon each half ten to fourteen tentacles, and at the point of division a rounded organ composed of a number of triangular lamellæ. This lobe (the inferior labial of Owen) is wanting in the male Nautilus; instead is found, nearly hidden beneath the buccal mass, a rounded organ, which is named, from its discoverer, *Van der Hoeven's organ*. I think that anatomical evidence is strong enough to convince us that the inferior labial lobe and Van der Hoeven's organ are homologous organs.

There are about sixteen lamellæ in the group in the centre of the inferior labial lobe. The group is separated at the median line into two halves, the lamellæ of each side facing each other. The largest lamellæ are at the centre of the group, the smallest at the exterior. The lamellæ are marked upon both surfaces by grooves parallel to their bases. A nerve showing some traces of ganglionic enlargements runs to the tip of each lamella. The nerves of the lamellæ of each half of the group unite. The trunk thus formed unites with the nerves of the tentacles of the lobe of its own side and the common trunk enters the pedal ganglion near the median line. The tentacles of each lobe are largest near the outer end of the series. They grow smaller and smaller as the median line is approached; those nearest the median line are frequently so small as to be scarcely visible. At this point it is possible to find a complete series of gradations between the lamellæ of the median organ and the tentacles. The structure of the lamellæ confirms the suspicion that they are modified tentacles. This homology has been suggested by Van der Hoeven.

Between the bases of each two lamellæ is a pit lined by exceedingly slender epithelial cells. These cells are also from two to three times the height of ordinary epithelial cells. The cells bear cilia, apparently each cell bearing a single cilium; but the preservation of my material is not good enough for me to make sure of this point. Fine fibres appear to run from the bases of the cells into the tissues.

As has been said, Van der Hoeven's organ occupies the same place in the male that the inferior labial lobe occupies in the female. This organ is about 1 inch in length, $\frac{3}{4}$ inch in breadth, and $\frac{2}{5}$ inch in thickness. It is enveloped by a tunic, which, over the anterior dorsal half, is free from the organ, thus allowing free communication between the interior of the organ and the exterior. The anterior half of the organ is separated into halves by a narrow vertical slit which leads into the central cavity. This is a low horizontal cavity extending from side to side.

At the anterior end, on each side of the opening, are a number of low, thick, vertical lamellæ, which quickly pass into thin, broad, shelf-like, horizontal lamellæ, which extend as far back as the posterior limit of the vertical slit-like opening of the organ. Back of this point the organ is glandular; the glands completely surround the central cavity. The glands are typical examples of the compound-tubular type. The epithelial cells of both glands and lamellæ are tall and cylindrical. The cells of the lamellæ are for the most part heavily loaded with secretory products. The cells of the glands are also loaded. Yet the lumens of the glands, as well as the central cavity, are entirely free from secretion, this evidently being stored in the cells till needed for some unusual purpose.

Another kind of cell is found among the epithelial cells of both glands and lamellæ. Around each epithelial cell are several fine hair-like sensory cells. The middle of each is swollen by the elongated oval nucleus. The tip of each cell is produced into a stiff sensory hair. The immense number of these cells bearing hairs makes the surface appear densely ciliated. The ordinary epithelial cells are of so much greater bulk than the sensory cells that close examination is required to reveal the fact that the cilia do not belong to them. I have seen the bases of the sensory cells continued for some distance into the submucous tissue as fine fibres of about the same diameter as the cell.

The nerves which innervate Van der Hoeven's organ have the same place of origin as those which innervate the inferior labial lobes of the female. One nerve enters each side of Van der Hoeven's organ and divides into a large number of branches. One of these runs into each lamella and several supply the glandular portion of the organ.

The number of lamellæ of Van der Hoeven's organ closely corresponds to the number of tentacles plus lamellæ of the inferior labial lobe. The innervation is the same in each, except that the nerve seems to form all its branches at one point in Van der Hoeven's organ, instead of at two points as in the labial lobe. The musculature of the one is the same as of the other. Willey finds that the same arteries supply both organs, and upon this fact bases the suggestion that they may be homologous. The sensory cells of Van der Hoeven's organ evidently correspond to those found between the bases of the lamellæ on the labial lobe; only in the one case they are restricted to definite areas, while in the other they are scattered throughout the organ. In short, anatomical evidence admits of no conclusion but that Van der Hoeven's organ of the male Nautilus is strictly homologous with the inferior labial lobe of the female Nautilus.

From the fact that the glandular cells in my sections of Van der Hoeven's organ are nearly all heavily loaded, and that absolutely no secretion is present in the lumens of the glands or in the central cavity of the organ, it appears that its glandular function may be limited to certain times and conditions, possibly connected with reproductive processes. The sensory function is probably the same in both sexes and continually active, though it is possible that this also may be closely connected with reproduction.

The structure of the hectocotylus (or spadix) has recently been admirably described by Vayssière. Still, there are several points which may be added to his description.

The hectocotylus is composed of a group of four tentacles. These become highly modified. The organ is usually situated upon the left side; but in between twenty and twenty-five per cent. of my specimens it is upon the right side. In one case hectocotyli are upon both sides. On the opposite side of the animal from the hectocotylus is a similar group of four tentacles, but unmodified.

Three of the tentacles forming the hectocotylus are closely enveloped by a fleshy sheath, the fourth and smallest only partly. On the external side of the sheath at the margin is a circular glandular area. The glands are compound-tubular, branched quite simply; they extend, in a direction perpendicular to the surface, about three quarters of the distance through the sheath. Upon examining the corresponding portion of the sheath of the similar group of the opposite side I found a glandular area in the same position as that upon the sheath of the hectocotylus. The area is smaller, the glands are less developed, yet are exactly similar in structure. The presence of this gland on both groups of tentacles is extremely interesting, as it *may* indicate an original hectocotylization of both groups.

In the second tentacle of the hectocotylus (the tenth cirrus of Vayssière) is another interesting series of glands. This tentacle is annulated, the grooves being deepest upon the upperside. Into each groove upon this side opens a row of perfectly simple sac-like glands. The openings are exceedingly small and are well hidden in the depths of the grooves. A single layer of columnar epithelial cells lines the gland. The cells of the neck of the gland are low, but they rapidly increase in height as they pass into the gland, so that the body of the gland is lined by exceedingly high cylindrical cells.

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